CLAIMS

1.   A calibrating method for a heat treatment apparatus that includes a processing vessel for accommodating a process object therein, a plurality of heaters and a plurality of temperature sensors; that stores a thermal model for estimating temperature of the process object in the processing vessel based on outputs of the temperature sensors; that estimates the temperature of the process object in the processing vessel based on the outputs of the temperature sensors by using the thermal model; and that controls the heaters based on the estimated temperature, to perform a heat treatment to the process object, said method comprising the steps of:

driving the heaters to heat an interior of the processing vessel;

measuring temperature in the processing vessel; and

calibrating the thermal model so that estimated value of the temperature substantially coincide with the actual measurement value of the temperature, upon comparison of the measured temperature in the processing vessel with temperature of the process object estimated by using the thermal model.

2.   The calibrating method for the heat treatment apparatus according to claim 1, wherein

the processing vessel is capable of accommodating a plurality of process object; and

the temperature measuring step includes a step of arranging the temperature sensors adjacent to the process objects and a step of measuring the temperatures of the process objects by means of the temperature sensors thus arranged.

3.   The calibrating method for the heat treatment apparatus according to claim 1 or 2, wherein the calibrating step calculate a correction value for the estimated value based on the

measured temperature and the estimated temperature, and calibrates the thermal model so that the estimated value is corrected by using the correction value.

4.   The calibrating method for the heat treatment apparatus according to claim 1 or 2, wherein:

the heating step drives the heaters to sequentially set the interior of the processing vessel to preset temperatures of a plurality of levels;

the temperature measuring step measures temperatures in the processing vessel at the preset temperatures, respectively;

a step of estimating the temperature of the process object estimates temperature of the interior of the processing vessel under the preset temperature of each of the levels; and

the calibrating step calibrating step calculates correction values for the estimated values based on the measured temperatures and the estimated temperatures, and calibrates the thermal model so that the estimated values estimated by the thermal model are corrected by using the correction values.

5.   The calibrating method for the heat treatment apparatus according to any one of claims 1 to 4, wherein:

the thermal model has a function of estimating temperature of the heater and temperatures of the temperature sensors; and

the calibrating step calculates a correction value based on a relationship between an amount of change in the temperature of the heater and an amount of change in the measured temperature of each of the temperature sensors, and also based on a difference between the temperature of one of the temperature sensors located closest to the heater estimated by using the thermal model and that actually measured, and calibrates the thermal model so that a estimated value is corrected based on the correction value.

6.   The calibrating method for the heat treatment apparatus according to any one of claims 1 to 4, wherein:

an inside heater is arranged in the processing vessel;

the thermal model has a function of estimating temperature of the inside heater; and

the calibrating step calculates a correction value based on a relationship between an amount of change in the temperature of the inside heater and an amount of change in the measured temperature of each of the temperature sensors, and also based on a difference between the temperature of one of the temperature sensors located closest to the inside heater estimated by using the thermal model and that actually measured, and calibrates the thermal model so that a estimated value is corrected based on the correction value.

7.   The calibrating method for the heat treatment apparatus according to any one of Claims 1 to 4, wherein:

first and second heaters are arranged above and below the process object in the processing vessel, respectively;

the thermal model has a function of estimating temperatures of the first and second heaters; and

the calibrating step calculates a first correction value based on a relationship between an amount of change in the temperature of the first heater and an amount of change in the measured temperature of each of the temperature sensors, and also based on a difference between the temperature of one of the temperature sensors located closest to the first heater estimated by using the thermal model and that actually measured; and calculates a second correction value based on a relationship between an amount of change in the temperature of the second heater and an amount of change in the measured temperature of each of the temperature sensors, and also based on a difference between the temperature of one of the temperature sensors located closest to the second heater estimated by using the thermal model and that actually measured; and calibrates the thermal model so that a estimated

value is corrected based on the first and second correction values.

8.   A heat treatment method comprising the steps of:

estimating temperature in the processing vessel by using the thermal model calibrated by the calibrating method for a heat treatment apparatus according to any one of Claims 1 to 7; and

applying a heat treatment on a process object based on the estimated temperature.

9.   A heat treatment apparatus that includes a processing vessel for accommodating a process object therein, a plurality of heaters and a plurality of temperature sensors; that stores a thermal model for estimating temperature of the process object in the processing vessel based on outputs of the temperature sensors; that estimates the temperature of the process object in the processing vessel based on the outputs of the temperature sensors by using the thermal model; and that controls the heaters based on the estimated temperature, to perform a heat treatment to the process object, said apparatus comprising:

means for driving the heaters to heat an interior of the processing vessel;

means for measuring temperatures of the process object in the processing vessel; and

means for calibrating the thermal model so that estimated value of the temperature substantially coincide with the actual measurement value of the temperature, upon comparison of the measured temperature in the processing vessel with temperature of the process object estimated by using the thermal model.